VS1103b Greeting Card

VSMPG "VLSI Solution Audio Decoder"

Project Code:
Project Name: VSMPG

Revision History			
Rev.	**Date**	**Author**	**Description**
1.00	2008-11-10	HH	Now with MIDI support.
1.00	2008-06-11	HH	Initial version.

Table of Contents

1 Introduction

The VS1103b Greeting Card application is a low-power application that allows the user to record and play back an audio message. The application has been designed in such a way that two inexpensive batteries (E.g. CR2016) can be used to power the device.

The device allows for a message to be recorded. There are three different modes:

1. Plain recording and playback.
2. Recording while MIDI is playing and plain playback (karaoke).
3. Plain recording and playback while MIDI is playing.

When the greeting card is opened, the message recorded by the user is automatically played.

1.1 The Demonstration Board

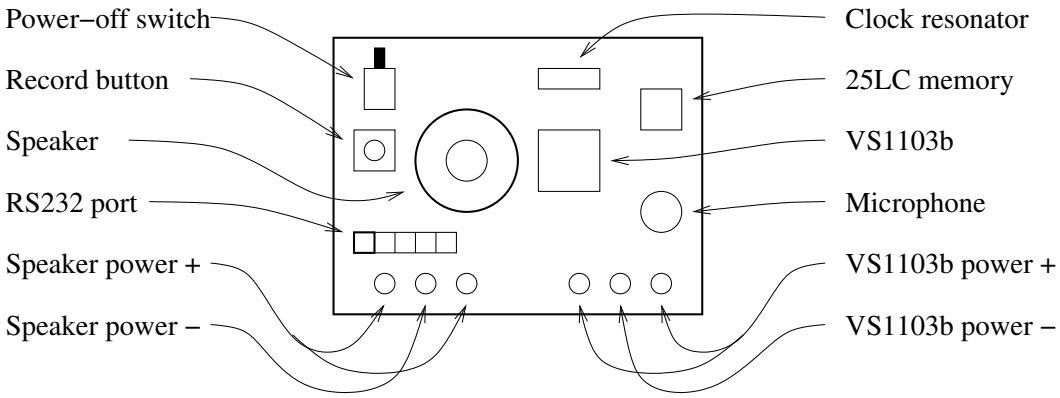

Figure 1.1: VS1103b Greeting Card Main Components

Figure 1.1 shows the main components of the VS1103b Greeting Card.

- Pushing the Power-off switch cuts off the power to VS1103. The greeting card should be designed so that when the postcard is closed, the DSP is not powered, and when it is opened, the DSP is powered.
- The record button activates message recording.
- The speaker plays back the audio. It should be placed carefully for maximum audio quality.

- The RS232 port can be used to connect the board to a computer and load the initial firmware the the FLASH. If the FLASH has been preprogrammed, there is no need to populate these pins.
- Speaker power is supplied from a battery through the Speaker power pins. There are two positive pins for compatibility with batteries of similar configuration. For test purposes these can be combined with VS1103b power pins.
- VS1103b power pins are used to supply digital power to VS1103b and SPI FLASH memory.
- The clock resonator chooses the recording and playback speed. Nominal frequency is 12 MHz.
- The firmware and recorded material is stored on a SPI FLASH memory. The memory must have 64 KiB sectors, erasable with the *0xD8 Sector Erase* command. The size must be at least 128 KiB (1 megabit). See Chapter 2 for details.
- VS1103b is a DSP that controls the device.
- Microphone is used to record user audio.

Speakers and VS1103b should be powered up with either an 2.8 V external source (in which case the two sets of power pins may be coupled) or from 3 V battery cells, e.g. CR2016, in which case two batteries are required. It is important to have two batteries so that the VS1103b processor is independent of speaker power consumption.

1.2 Three Different Applications

There are three different applications provided, numbered from 1 to 3. They perform the postcard function slightly differently, and two of them have different configurable parameters that can be set with the program `gcardset.exe`. All applications, with the exception of App 1 must have a 12 MHz clock.

1.2.1 App 1: Plain Greeting Card

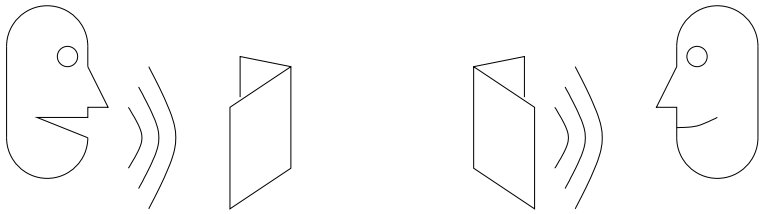

Figure 1.2: App 1: Plain Greeting Card

Application 1 lets the user record and play back a message. This is essentially the same as VS1103b Greeting Card v1.10 Simple Recording Application.

How to Use

- Open the card (= turn the power on). If there is a message, it will be played back. Otherwise the card will stay silent.
- Push the button to start recording.
- You will hear five beeps.
- After the beeps, you can start recording.
- Recording is stopped when either you push again the button or when the memory card is full.

Configurable Parameters

There are no configurable parameters in App 1.

Recording Samplerate

Recording samplerate can be adjusted by adjusting the external clock / resonator. Samplerate $f_s = \frac{x}{512}$, where x is the clock frequency in Hz. However, during programming clock must be between 12 and 12.288 MHz.

Example: When using a 6 MHz resonator, $f_s \approx 11719$ Hz.

1.2.2 App 2: Karaoke Greeting Card

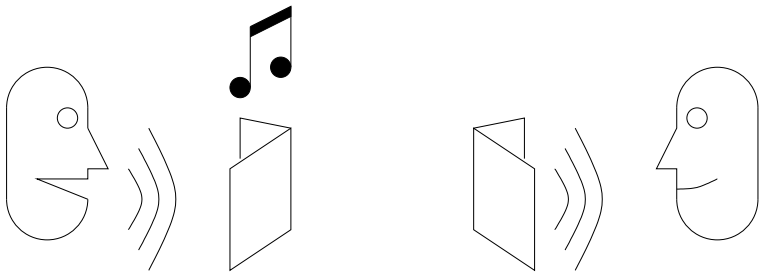

Figure 1.3: App 2: Karaoke Greeting Card

Application 2 lets the user record and play back a message in such a way that a MIDI tune is played back at the same time the sender is recording the message. This can be used for e.g. birthday greetings.

How to Use

- Open the card (= turn the power on). If there is a message, it will be played back. Otherwise the card will stay silent.
- Push the button to start recording.
- You can begin your message / karaoke performance when the MIDI tune starts playing.
- Recording is stopped when either you push again the button or when the memory card is full.

Configurable Parameters

Parameter	Default	Min	Max	Description
-m x	18[1]	1	31	MIDI volume in dB
-a x	31	1	31	ADPCM volume in dB
-t x	12[2]	-24	48	Transpose MIDI x halftones

[1] Turning the level up will make the background music clearer, but it may also make it more difficult to understand what the sender says. Best level depends on the acoustics, speaker and microphone of the final product.
[2] 12 halftones is one octave. As a default this device will play MIDI tunes one octave higher than nominal. To play at nominal frequency, set this parameter to 0.

Recording Samplerate

Recording samplerate $f_s \approx 7812\,\text{Hz}$.

1.2.3 App 3: Greeting Card with Background Music

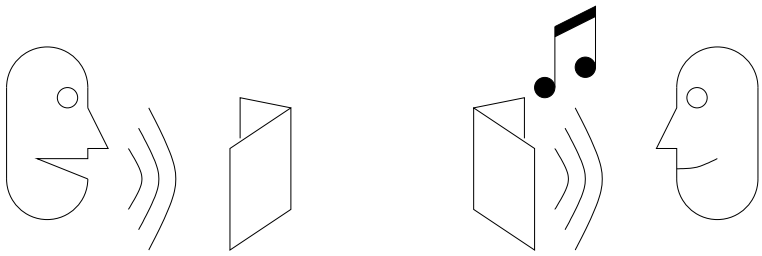

Figure 1.4: App 3: Greeting Card with Background Music

Application 3 lets the user record and play back a message in such a way that a MIDI tune is played back at the same time the receiver is listening to the message.

How to Use

- Open the card (= turn the power on). MIDI backgroudn music will start playing. If there is a message, it will also be played back at the same time.
- Push the button to start recording.
- You will hear five beeps.
- After the beeps, you can start recording.
- Recording is stopped when either you push again the button or when the memory card is full.

Configurable Parameters

Parameter	Default	Min	Max	Description
-m x	16	1	31	MIDI volume in dB
-a x	31	1	31	ADPCM volume in dB
-t x	12[1]	-24	48	Transpose MIDI x halftones
-d x	4[2]	2	6	Recording samplerate divider, fs = 46875/x

[1] 12 halftones is one octave. As a default this device will play MIDI tunes one octave higher than nominal. To play at nominal frequency, set this parameter to 0.
[2] See "Recording Samplerate".

Recording Samplerate

Recording samplerate depends on the samplerate divider as set with parameters "-d": 2 = 23437 Hz, 3 = 15625 Hz, 4 = 11718 Hz, 5 = 9375 Hz, 6 = 7812 Hz

2 Recording Time

The VS1103b Greeting Card Application automatically detects the size of the SPI FLASH memory it has been connected to. Thus, recording time is limited by the size of the FLASH memory and samplerate.

2.1 Calculating Recording Time

The first 64 KiB of the card is always reserved for the application itself and cannot be used for recording.

The formula for maximum recording time t in seconds with a given memory capacity c in bits is $t = \frac{(c-524288)\times 505}{f_s \times 2048}$.
Example: When using a "8 Mbit" memory (actually 8 Mi-bit or 8×2^{20} bit memory) and a samplerate of 11719 Hz, recording time $t \approx 165$ s.

2.2 Design for Good Sound Quality

Speaker placement has a dramatical effect on sound quality.

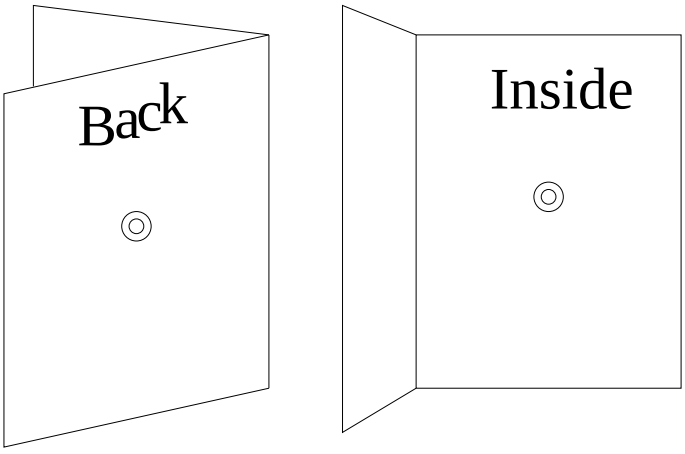

Figure 2.1: Suggested Speaker Placement

One speaker placement solution that gives good sound quality is presented in Figure 2.1. In this solution the speaker has been punched through the back page of the greeting card so that the speaker is facing the inside of the card.

3 Building an Image File

3.1 App 1 Image File

Application 1 is not configurable, and the associated image file `gc110app1.img` can be used as is. You only need to copy it to the filename `boot.img` before loading the firmware as shown in Chapter 4.

3.2 App 2 and 3 Image Files

To build an image file you will need one of the greeting card application files and a MIDI file. You can concatenate these files with `gcardset.exe`, provided with this software.

`gcardset.exe` is used from the *DOS Prompt* as follows:
gcardset [-h] [-m x] [-a x] [-t x] [-d x] inFile.img [midiFile.mid boot.img]
If `midiFile.mid` and `boot.img` are not provided, only the contents of the image file are displayed.

Example command:
`gcardset [-t 0] [-d 3] gc110app3.img myMidi.mid boot.img`

This will produce the following output:

```
GCardSet: Image file "gc110app3.img", Rev 1.10 App 3, parameters:
  Def. Min. Max. Set  Name
    16    1   31   - MIDI volume in dB
    31    1   31   - ADPCM volume in dB
    12  -24   48   0 Transpose MIDI x halftones
     4    2    6   3 Sample rate divider, fs = 46875/x

Writing combined image to "boot.img".. ok
```

Now a file called `boot.img` has been created, and this can then be transferred to a FLASH memory as shown in Chapter 4.

Note: The total size of the image file and MIDI file must not exceed 64 KiB, or 65536 bytes.

4 Loading New Firmware

After you have created a boot image file with the name `boot.img` as shown in Chapter 3, you can load it to FLASH memory.

To load a the firmware to a board, first connect an RS232 adapter to a computer and the board. If you don't have an adapter, you can order one from VLSI Solution or build it yourself: the adapter consists of one single MAX3232 compatible RS232 signal converter. Then check whether the board is connected to COM1, COM2 or COM3.

First turn the card power on. Then program the SPI FLASH using `gcard1.bat`, `gcard2.bat` or `gcard3.bat`, depending on the COM port. If your COM port has a higher number than 3, change the "-p" parameter in the `.BAT` file. When running the script, you should see output that looks roughly like this:

```
VSEMU 2.1 Nov 28 2007 11:50:01(c)1995-2007 VLSI Solution Oy
Using serial port 6, COM speed 1200 (x 8 = 9600)
Waiting for a connection to the board...
Chip version "1033"
Stack pointer 0x1920, bpTable 0x594f
User program entry address 0x30
prom.bin: includes optional header, 20 sections, 687 symbols
Section 1: abs_x       page:1 start:6272 size:192 relocs:0 fixed
Section 2: abs_y       page:2 start:6272 size:192 relocs:0 fixed
[ ...MANY SIMILAR LINES REMOVED... ]
Section 20: VS_stdiolib$0  page:0 start:704 size:134 relocs:37
> e
1f28
 div
0000
 status
ffff
ffff
Erase..
done
0000
1000
1200

Finished!!
```

Programming should last between 10-60 seconds depending on the size of the image.

The scripts assume you are using a 12 MHz or 12.288 MHz oscillator / resonator.

If you are using App 1 and your clock is 6 MHz, change "-s 9600" to "-s 4800" in your script. If the clock is 3 MHz, change it to "-s 2400". Other clock frequencies are not directly supported. If you want to produce units that runs on another clock, you have to either replace the clock after programming or preprogram the FLASH memories using a separate jig.

5 Files

Files in this software package are as follows.

- `docs/` Documentation (directory).
- `execute.cmd` Needed by the `.BAT` files.
- `gc110app1.img, gc110app2.img, gc110app3.img` Greeting Card Applications 1, 2 and 3, without MIDI tunes.
- `gcard1.bat, gcard2.bat, gcards3.bat` Program file called `boot.img` to the board from serial ports COM1, COM2 and COM3, respectively.
- `gcardset.exe` PC/Windows program to build bootable image files.
- `hw_desc` VS1103 hardware description file.
- `layout/` Schematics and Layout files (directory).
- `mem_desc` VS1103 memory description file.
- `prom.bin` FLASH programmer.
- `vs3emu.exe` VS1103 emulator.

The `docs/` directory contains the following files:

- `okortti11_bom_a.txt, okortti11_bom_s.txt` Bill of Materials in two different text formats.
- `VS1103GreetingCardV110.pdf` Instructions; this file.

The `layout/` directory contains the following files:

- `*.tx, *.txf, *.NTR` Three alternative Integra's internal formats.
- `*.G*` Gerber files.
- `*.nc, *_drl.txt` Excellon drill files.
- `*.pdf` PDF images: schematics and layout.
- `*.dxf` Exported AutoCAD (not tested, may not work).

6 Contact Information

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